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(56) Documents Cited
GB 2246471 A EP 0202335 A1 JP 040245684 A
JP 020252273 A JP 010154542 A US 4394600 A

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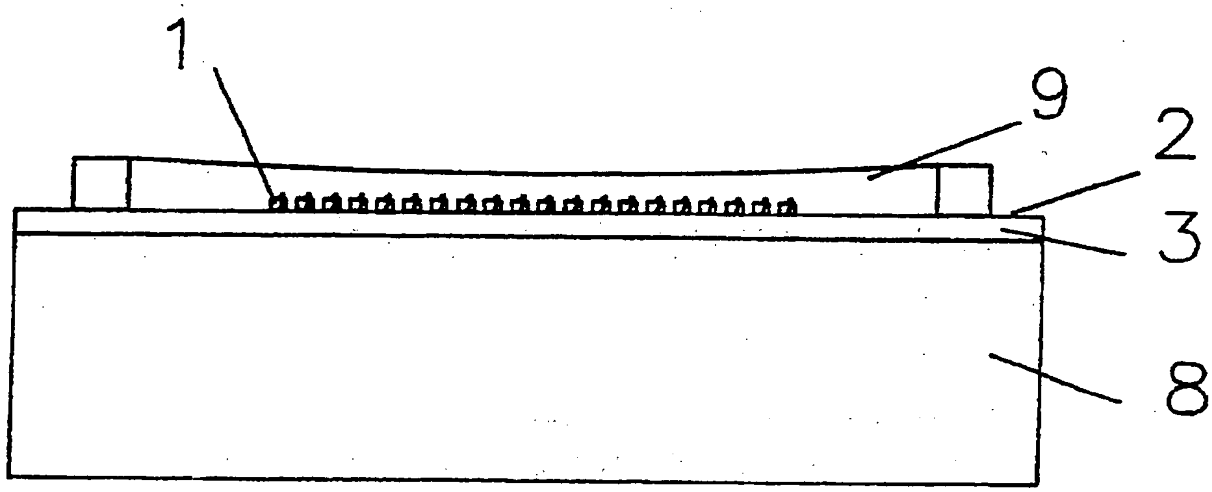
ON-LINE DATABASES: WPI

(54) **A Radiation source**

(57) A radiation source for emitting high intensity light close to the emitting surface thereof, includes a thermally conductive substrate (3); a densely packed two dimensional array (1) of light emitting diodes formed on a surface of the substrate, the emission spectrum of the array being matched to that required by a particular application of the radiation source; means for applying relatively high drive currents to each of the diodes; and heat sinking means (8), such as a water cooled heat sink, for dissipating the heat generated by the diodes.




SECTION THROUGH AA
FIGURE 2

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

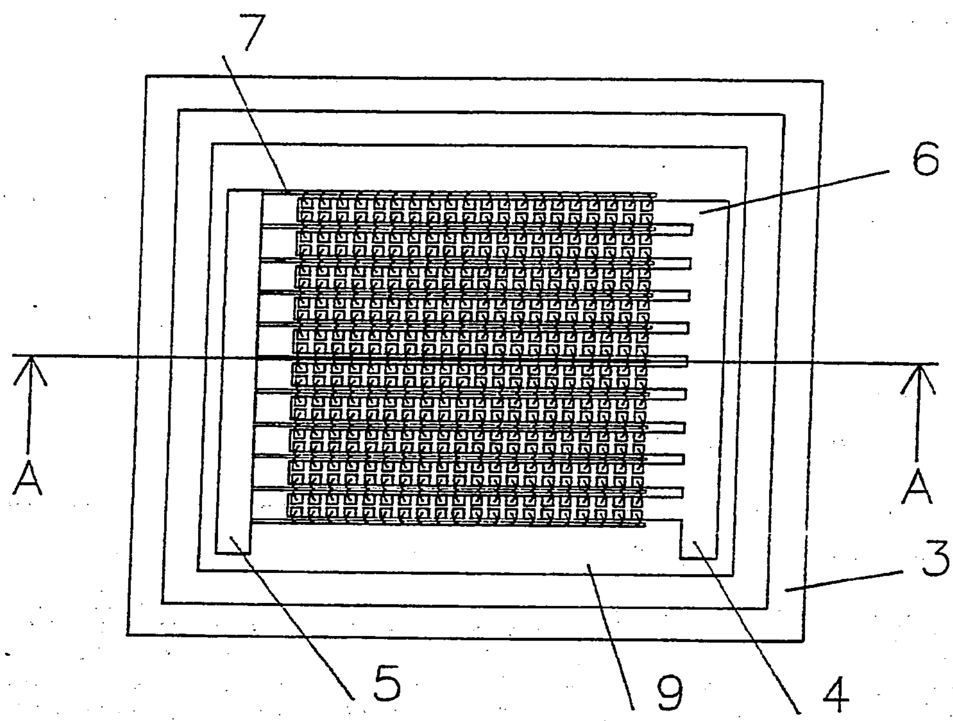
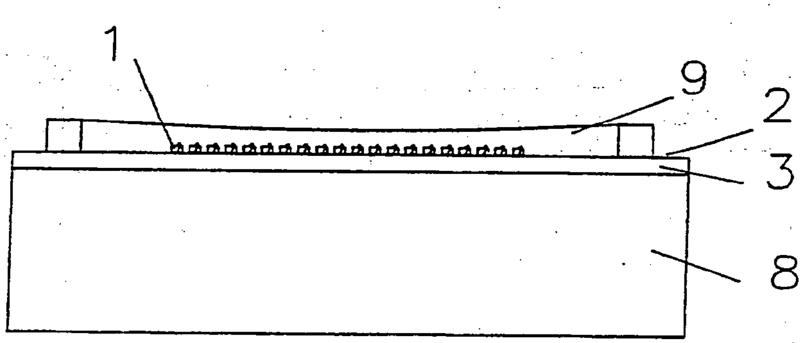



FIGURE 1




SECTION THROUGH AA
FIGURE 2

# A RADIATION SOURCE

The invention relates to a radiation source for emitting high intensity light close to the emitting surface thereof.

It is known to use various types of laser in applications where high levels of illumination are required at specific wavelengths in the visible, or infra-red, regions of the spectrum. In some of these applications, there are significant disadvantages in the use of lasers because the laser beam produces a very intense local radiation level rather than a more diffuse level over an area of several square centimetres. In addition, lasers for some regions of the spectrum are very expensive and require specialist personnel for there operation and maintenance.

It is an object of the present invention to overcome the foregoing problems by providing a low cost, non-lasing, radiation source including a light emitting diode array for emitting high intensity light close to the emitting surface thereof.

The invention provides a radiation source for emitting high intensity light close to the emitting surface thereof, including a thermally conductive substrate; a densely packed two dimensional array of light emitting diodes formed on a surface of the substrate, the emission spectrum of the array being matched to that required by a particular application of the radiation source; means for applying relatively high drive currents to each of the diodes; and

heat sinking means for dissipating the heat generated by the diodes.

In some applications, the radiation levels required are typically in the range 10 to 200 joules/cm$^2$, depending on the particular application, and this needs to be achieved at an intensity in the range from 100 to 200 mW/cm$^2$ for periods between 100 to 1000 seconds. The radiation source according to the present invention is capable of achieving these radiation levels.

The front surface of the LED array is preferably encapsulated with a thin layer of an encapsulant, for example, transparent silicone, to provide mechanical strength, and the array can include optical means, for example, micro-lenses, for increasing the intensity of the local radiation close to the front surface of the array.

The diodes of the array can be powered by a simple constant current supply connected to a suitably patterned metallisation layer formed on the surface of the substrate and including an anode track and a cathode track. The substrate is preferably of alumina.

According to one aspect of the present invention, the quantum efficiency of the light emitting diodes is in the range 1 to 5 %.

According to another aspect of the present invention the light emitting diodes are in the form of GaAlAs light emitting diode chips, and have a quantum efficiency of the order of 2%.

According to another aspect of the present invention the size of the array is of the order of 1.0 x 1.0 $cm^2$, and each of the chips are 0.3 x 0.3 $mm^2$, and have a pitch of 0.5 mm.

According to another aspect of the invention, the mean drive current of each chip is in the range 50 to 100 mA, and the total array dissipation is in the range 50 to 100 Watts.

According to another aspect of the invention the temperature rise of the array is limited to $20^0C$ by the heat sinking means which are preferably in the form of a water cooled heat sink.

According to another aspect of the invention the light emitting diodes are in the form of InGaAlP light emitting diode chips.

The invention also provides a method of irradiating a region of a member with high intensity illumination utilising a radiation source according to the present invention having the front surface thereof situated in close proximity to the said region of the member.

The forgoing and other features according to the present invention will be better understood from the following description with reference to the accompanying drawings, in which:

Figure 1 illustrates, in a plan view, a radiation source according to the present invention, and

Figure 2 illustrates, in a cross-sectional side elevation, the radiation source illustrated in Figure 1.

It is normally assumed that the levels of radiation referred to above cannot be achieved with non-lasing light emitting diodes (LEDs), because of their relatively low efficiency, i.e. around 1% or less, and the fact that the light emission is over a large solid angle, unless specially encapsulated or lensed.

However, the required intensity levels can be obtained close to the emitting surface of the LED array of the radiation source according to the present invention.

The radiation source according to the present invention utilises a densely packed LED array that is constructed using LEDs having quantum efficiencies in the range 1 to 5% and that is driven at high current levels. The LED array is provided with adequate heat-sinking in order to prevent overheating. Typically, the heat-sinking can be effected by a cooled heat sink, for example a water cooled heat sink.

The radiation source illustrated in a plan view in Figure 1 of the accompanying drawings includes a densely packed two dimensional array of GaAlAs LED chips 1 having a quantum efficiency of the order of 2%. The emission spectrum of the LED chips 1 is closely matched to that which is required for a particular application of the radiation source.

The LED chips 1 are 0.3 x 0.3 $mm^2$, and are assembled in an array with a pitch of 0.5 mm. The overall size of the array is of the order of 1.0 x 1.0 $cm^2$.

As is best illustrated in Figure 2 of the accompanying drawings, the array of LED chips 1 are assembled on the surface 2 of a substrate 3 of good thermal conductivity, for example, alumina. A suitably patterned metalisation layer formed on the surface 2 and consisting of an anode track 4 and a cathode track 5 provides the required interconnections for the chips 1 so that the mean drive current of each diode can be in the range 50 to 100 mA, and the total array dissipation in the range 50 to 100 Watts.

The comb-like structure of the anode track 4 is such that each of the limbs 6 provides the anode connection for two adjacent rows of the LEDs 1, and the narrower limbs 7 of the comb-like structure of the cathode track 5 are situated, one on each side, of the limbs 7. The two outer limbs 7 provide the cathode connections for

respective ones of the first and last row of LEDs and the other limbs 7 each provide the cathode connections for adjacent rows of LEDs

As illustrated in Figure 2 of the accompanying drawings, the radiation source according to the present invention includes a cooled heat sink 8, for example, a water cooled heat sink, secured in thermal contact with the substrate 2. The heat sink 8 is adapted to limit the temperature rise of the LED array to a level of the order of $20^0$C.

As is also illustrated in Figure 2 of the accompanying drawings, the LED array is encapsulated with a thin layer 9 of a suitable encapsulant, for example, transparent silicone, in order to provide mechanical protection for the LED array, whilst at the same time making it possible to bring the emitting area of the LED array close to the region requiring irradiation.

The LED array of the radiation source according to the present invention can be fabricated from other LED chip materials, for example, InGaAlP could be used to provide effective emission at a selected wavelength.

The radiation source according to the present invention could also use optical techniques, such as micro-lenses, in order to further increase the local radiation intensity close to the surface of the LED array.

The essential aspects of the radiation source according to the present invention is the use of LEDs of adequate efficiency, the careful matching of the LED emission spectrum to that required by the particular application of the radiation source, and the good design of the LED assembly and packaging to ensure that heat is conducted away from the diodes.

The radiation source according to the present invention can be used in any application where localised irradiation with a high intensity light of a selected wavelength is required.

## CLAIMS

1. A radiation source for emitting high intensity light close to the emitting surface thereof, including a thermally conductive substrate; a densely packed two dimensional array of light emitting diodes formed on a surface of the substrate, the emission spectrum of the array being matched to that required by a particular application of the radiation source; means for applying relatively high drive currents to each of the diodes; and heat sinking means for dissipating the heat generated by the diodes.

2. A radiation source as claimed in claim 1 wherein the quantum efficiency of the light emitting diodes is in the range 1 to 5 %.

3. A radiation source as claimed in claim 1 or claim 2 wherein the light emitting diodes are in the form of GaAlAs light emitting diode chips, and wherein the quantum efficiency of the chips is of the order of 2%.

4. A radiation source as claimed in claim 3 wherein the size of the array is of the order of 1.0 x 1.0 $cm^2$, and wherein each of the chips are 0.3 x 0.3 $mm^2$, and have a pitch of 0.5 mm.

5. A radiation source as claimed in claim 3 or claim 4 wherein the mean drive current of each chip is in the range 50 to 100 mA, and wherein the total array dissipation is in the range 50 to 100 Watts.

6. A radiation source as claimed in any one of the claims 3 to 5 wherein the temperature rise of the array is limited to $20^{0}C$ by the heat sinking means.

7. A radiation source as claimed in claim 1 or claim 2 wherein the light emitting diodes are in the form of InGaAlP light emitting diode chips.

8. A radiation source as claimed in any one of the preceding claims wherein the front surface of the array is encapsulated with a thin layer of encapsulant to provide mechanical strength.

9. A radiation source as claimed in claim 8 wherein the encapsulant is transparent silicone.

10. A radiation source as claimed in any one of the preceding claims wherein the thermally conductive substrate is an alumina substrate.

11. A radiation source as claimed in any one of the preceding claims including optical means for increasing the intensity of the local radiation close to the front surface of the array.

12. A radiation source as claimed in claim 11 wherein the optical means include micro-lenses.

13. A radiation source as claimed in any one of the preceding claims wherein the diodes of the array are powered by a constant current supply.

14. A radiation source as claimed in any one of the preceding claims wherein the heat sinking means include a water cooled heat sink secured in thermal contact with the substrate.

15. A radiation source for emitting high intensity light close to the emitting surface thereof substantially as hereinbefore described with reference to the accompanying drawings.

16. A method of irradiating a region of a member with high intensity illumination utilising a radiation source as claimed in any one of the preceding claims having the front surface thereof situated in close proximity to the said region of the member.

**Patents Act 1977**
**Examiner's report to the Comptroller under Section 17 (The Search Report)** -11-

Application number

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**Relevant Technical fields**

(i) UK Cl (Edition L ) H1K (KPAD, KPDB); H2H (HLL3)

(ii) Int Cl (Edition 5 ) H01L, H05B

Search Examiner

W A MORRIS

**Databases** (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

Date of Search

27 MAY 1993

Documents considered relevant following a search in respect of claims 1 - 16

| Category (see over) | Identity of document and relevant passages | | Relevant to claim(s) |
|---|---|---|---|
| X | GB 2246471 A | (MIKOSHIBA et al) LED 15, Heatsink 16 | 1 at least |
| X | EP 0202335 A1 | (J T M T et al) LED 1, Heatsink 3/4 | 1 at least |
| X | US 4394600 | (FLANNAGAN) LED 42, Heatsink 10 | 1 at least |
| X | JP 04-245684 | (IWASAKI) LED 10, Heatsink 46. See Japio Abstract Accession No 92-245684 | 1 at least |
| X | JP 02-252273 | (FURUKAWA) LED 10, Heatsink 31. See Japio Abstract Accession No 90-252273 | 1 at least |
| X | JP 01-154542 | (HITACHI) LED 2 + Heatsink. See Japio Abstract Accession No 89-154542 | 1 at least |

| Category | Identity of document and relevant passages -12- | Relevant to claim(s) |
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**Categories of documents**

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

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